Thermal Conductivity of Zr-1% Nb

Preliminary Recommendation

The preliminary recommendation for the thermal conductivity of Zr-1%Nb are the equations obtained by Peletskii et al. [1] from measurements on Zr-1%Nb rods along the length of the rod. No data are available comparing thermal conductivity in different directions.

For the α-phase and β-phase from 300-1150 K,

$$\lambda\ (W{\cdot}m^{-1}{\cdot}K^{-1}) \;=\; 23.48 - 1.92\,\mathrm{x}\,10^{-2}\,T \;+\; 1.68\,\mathrm{x}\,10^{-5}\,T^{2} \qquad \textbf{(1)}$$

for the β-phase from 1150-1600 K,

$$\lambda\ (W{\cdot}m^{-1}{\cdot}K^{-1}) \;=\; 1.51 \;+\; 0.020\,T \qquad \textbf{(2)}$$

The experimental data and the recommended equations are shown in Figure 1. Tabulated values for the thermal conductivity of Zr-1% Nb are given in Table 1.

Uncertainty

The root-mean square deviation of the data from Eq.(1) is 0.32 $W \cdot m^{-1} \cdot K^{-1}$. The root-mean square deviation for Eq.(2) is 0.73 $W \cdot m^{-1} \cdot K^{-1}$. Figure 2 shows the percent deviations of the data from the recommended equations. All data are within 6% of the recommended equations. Because no other data are available for comparison, a 10% uncertainty appears reasonable.

Send comments to
jkfink@anl.gov

Discussion

Peletskii et al. [1] measured the thermal conductivity of Zr-1%Nb rods using a stationary heat flux method. This method is used to determine the thermal conductivity along the length of the rod. For Zr-1%Nb, no data were found comparing thermal conductivity in different directions. However, in the Russian International Nuclear Safety Center review [2] of the recommended equations given by the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE) [3], Efanov et al.[2] noted that thermal conductivity measurements on Zr-1%Nb by the Institute of Physics and Power Engineering (IPPE) give higher values for the α-phase thermal conductivity and these data have a different temperature dependence than the data of Peletskii et al. Unfortunately, no information is available regarding the IPPE measurements and the IPPE data have not been made available. It is possible that Efanov et al.[2] were referring to the measurements by Mikryukov [3] on Zr-1.5%Nb, which are high relative to the data of Peletskii et al.[1] for Zr-1%Nb and also high relative to Canadian and Chinese data for Zr-2.5%Nb. It is also possible that the source of the discrepancy between the IPPE data and the data of Peletskii et al. is that the measurements were done in different directions. However, insufficient information is available on the IPPE measurements to confirm this hypotheses.

References

1. V. E. Peletskii, A. P. Grishchuk, and Z. A. Musaeva, *The Kinetic Properties of E-11- Reactor Alloy in the High Temperature Range,* Teplofiz. Vys. Temp. **32**, No. 6, 820-824 (1994) [in Russian], High Temperature **32**, 766-770 (1994) [English translation].

2. A. D. Efanov, I. P. Smogalev, V. P. Bobkov, V. N. Vinogradov, and V. N. Roumyantsev, *Critical review of data and recommendations on zirconium-niobium alloys given in the IBRAE report NSI-SARR-34-96, RINSC Report* (October 1997).

3. V. T. Ozrin, V. Yu. Zitcerman, V. M. Gefter, and V. F. Bajbuz, *Material Properties for International Nuclear Safety Database,* IBRAE Report **NSI-SARR-34-96** (September 1996).

Send comments to
jkfink@anl.gov

Table 1 Thermal Conductivity of Zr-1% Nb

Temperature K	Thermal Conductivity W m^{-1} K^{-1}
300	19.2
400	18.5
500	18.1
600	18.0
700	18.3
800	18.9
900	19.8
1000	21.1
1100	22.7
1200	25.6
1300	27.6
1400	29.6
1500	31.6
1600	33.6

Send comments to
jkfink@anl.gov

Figure 1 Thermal Conductivity of Zr-1%Nb

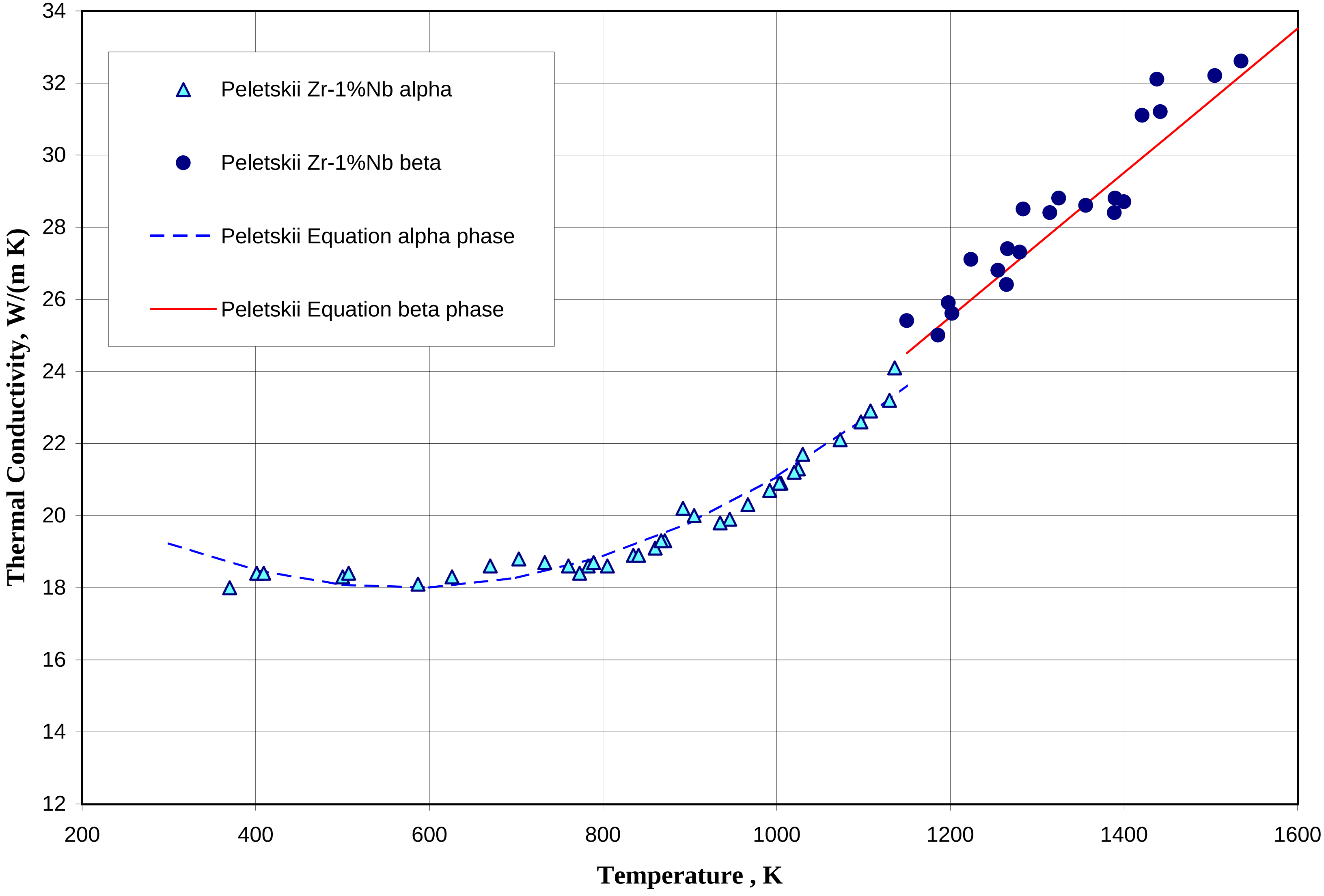

Figure 2 Deviation of Zr-1%Nb Thermal Conductivity Data from Equations